Silurian Brachiopods from the Bredbo Area North of Cooma, New South Wales, Australia

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The brachiopod faunas are described from three successive stratigraphic units in the Bredbo area, between Canberra and Cooma - the Cappanana Formation, Colinton Volcanics and lower Rothlyn Formation. The first two have type localities in the area. There are 16 species in all, most of which occur at least in the Cappanana Formation, but there are no implications of a useful biostratigraphic succession. Many species are common to the Delegate River Mudstone south of Cooma and the Canberra Formation in Canberra, and the only previously unknown species is a probable *Rhynchotrema*, represented by just a few specimens. Comparison with faunas of known age in the Canberra-Yass area indicate a Wenlock (Early Silurian) age, most likely Sheinwoodian. This supports the most recently proposed stratigraphic framework, and the likelihood that the volcanic units in the region were probably erupted over relatively brief intervals of time.

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KEYWORDS: Brachiopods, Bredbo, Cappanana Formation, Colinton Volcanics, Rothlyn Formation, Silurian, Wenlock.

INTRODUCTION

Bredbo village is about 60 km south of Canberra on the Monaro Highway, on the eastern side of the Murrumbidgee River valley (Fig. 1). While the existence of Silurian rocks had been known for some time, the first detailed study of the area was by Browne (1944), with subsequent work for the 2nd edition of the Canberra 1:250 000 geological sheet (Best et al. 1964). More detailed mapping was carried out for the Michelago 1:100 000 sheet (Richardson 1979), later revised by Henderson (1990). Henderson's work is the basis of the geological map in Fig. 1, and the following account. Pickett (1982:60-62) listed the fossils that had been reported (but not described) from the Silurian units. The present paper documents the brachiopod fauna from the Bredbo area, complementing the description by Strusz (2013) of very poorly preserved brachiopods from a southern continuation of one of the units, the Cappanana Formation, east of Cooma.

GEOLOGICAL SETTING

The Bredbo area lies on a narrow graben-like meridional extension of the Silurian Canberra-Yass Shelf between Canberra and Cooma. The Silurian rocks are in faulted contact with the Murrumbidgee Batholith to the west, and are faulted against or unconformably overlie Llandoverian graptolitic shale and Upper Ordovician sandstone and black shale to the east. Volcanic rocks of rhyolitic to dacitic composition dominate the succession, which comprises three conformable stratigraphic units: Cappanana Formation, Colinton Volcanics (both first used by Best et al. 1964) and Rothlyn Formation (introduced by Henderson 1990). The boundaries between these units are gradational, and not everywhere easily recognisable. Henderson thought the succession to be more akin to that in the Captains Flat basin to the east of Canberra, than to the rather more complex succession around Canberra itself. The type locality for the Cappanana Formation is along Cappanana Creek east of Bredbo, and for the

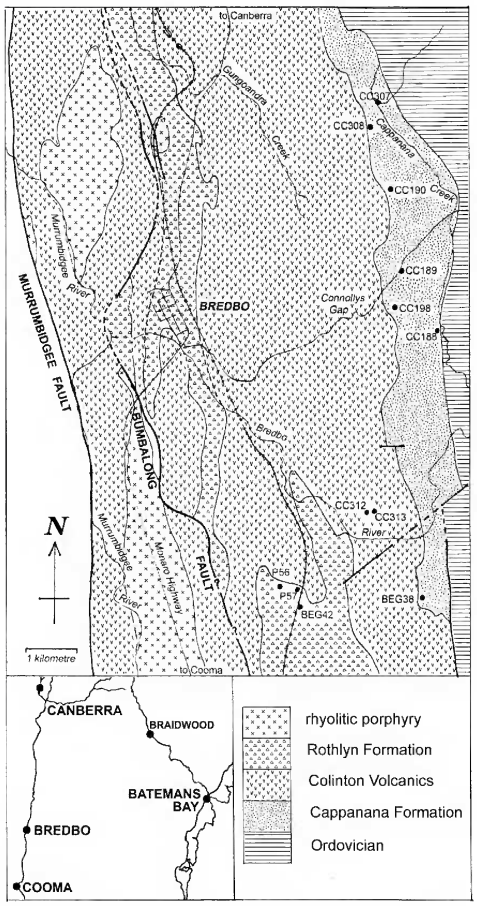

Figure 1. Geological map of the Bredbo area, simplified from Henderson (1990), showing localities referred to in this paper, and detailed in the Appendix. The rocks west of the Murrumbidgee Fault belong to the Murrumbidgee Batholith. Localities P56, P57 are those of Pillans (1974).

Colinton Volcanics is Colinton Hill, just north of the area shown in Figure 1.

Cappanana Formation

The unit immediately above the unconformity is the shallow-marine Cappanana Formation, comprising a discontinuous basal quartz-rich sandstone grading upward into shale and siltstone, some calcareous, with scattered thinly bedded and massive limestone lenses. Towards the top there are layers of dacitic tuff, mostly reworked. Thickness is 700 m or less. Macrofossils are common; those in the terrigenous beds appear to be mostly preserved as storm or slump deposits, and include shells and trilobites that are generally dissociated and often broken. Fossils in the finer-grained rocks are generally distorted, probably as a result of both burial compaction and subsequent tectonic compression.

Colinton Volcanics

Partly marine but mainly subaerial, this thick volcanic unit overlies the Cappanana Formation. The base is defined as the first major volcanic layer. The formation is mostly dacitic crystal tuff, with rhyolites in the upper part; there are sporadic flows. There are also interbedded siltstones, and occasional limestone lenses. The formation is thickest in the north (up to 4000 m), thinning southward with increasing sedimentary content until disappearing near Cooma. This suggests that the volcanic centre was in the north or northeast. The sedimentary rocks contain shelly fossils, indicating a marine environment.

Rothlyn Formation

The Rothlyn Formation extends from near Bredbo to south of Cooma, and has also been found in a small area west of Michelago. It overlies the Colinton Volcanics, the base being defined as the first thick shale or limestone above the Volcanics, and differs from that formation in the composition of its volcanic content, and the much greater proportion of sedimentary rocks (about 50%). Shales dominate the latter, but there are also some thick limestone lenses, and sporadic sandstone beds especially towards the top of the unit; fossils indicate a marine environment. Apart from minor basalt, the volcanic rocks are rhyolitic to mostly dacitic, and always porphyritic. Henderson (1990) considered the volcanic centre to lie east to northeast of Cooma.

CORRELATION AND AGE

Henderson's detailed mapping extended from the southern edge of the Canberra area to Cooma (Henderson 1990). He showed that near Tharwa at the southern edge of Canberra, the Williamsdale Dacite Member near the top of the Colinton Volcanics was petrographically and geochemically very similar to the Deakin and overlying Laidlaw Volcanics, differing in much higher content of titanium, magnesium and total iron oxides. The uppermost levels of the Colinton Volcanics a little to the south (south from Williamsdale) are rhyolitic to dacitic crystal tuffs very similar to dacitic crystal tuffs at the base of the Laidlaw Volcanics. In particular, these crystal tuffs both contain allanite. Henderson considered it

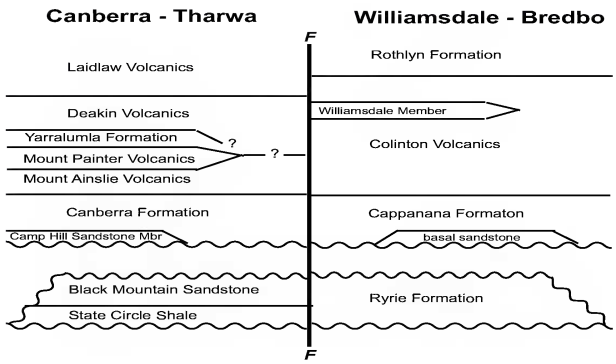

Figure 2. Correlation of Llandovery and Wenlock formations in the southern Canberra and Bredbo areas, based on Henderson (1990), Percival and Zhen (2017) and Strusz and Percival (in press).

	Cap	Col	Roth
Eopholidostrophia (Megapholidostrophia) sp.	▬		
Salopina mediocostata	▬		
Atrypoidea (Atrypoidea) australis	▬		
Navispira cf. *bicarinata*	▬		
?*Nucleospira paula*	▬		
Nanattegia? sp.	▬		
Hedeina oepiki	▬		
Janius bowningensis	▬	▬	
cf. *Clorinda* sp.	▬		▬
Mesoleptostrophia (Mesoleptostrophia) oepiki	▬	?	▬
Morinorhynchus cf. *oepiki*	▬	?	▬
Atrypa? sp.	▬	▬	▬
Spirinella caecistriata	▬	▬	▬
Epelidoaegiria minuta chilidifera		▬	
Rhynchotrema? sp.		▬	
Rufispirifer nucula?		▬	

Figure 3. Species range chart. Abbreviations: Cap - Cappanana Formation; Col - Colinton Volcanics; Roth - Rothlyn Formation (lower part).

probable that the uppermost Colinton Volcanics were coeval with the lower Laidlaw Volcanics. It follows from this that the shales overlying this level in the Laidlaw Volcanics are readily correlatable with the onset of sedimentation in the Rothlyn Formation, overlying the Colinton Volcanics.

The Cappanana Formation north of Bredbo is unconformable on the Ryrie Formation, consisting of a basal siltstone overlain by sandstone and minor interbedded siltstone. The siltstone has yielded a sparse graptolite fauna of late Llandovery age (Richardson and Sherwin 1975). This can be correlated with the State Circle Shale in Canberra, also with late Llandovery graptolites (Strusz and Jenkins 1982) and overlain by sandstone (the Black Mountain Sandstone). These are unconformably overlain by the Camp Hill Sandstone Member at the base of the Canberra Formation (Henderson 1981). There is similarly a discontinuous sandstone layer at the base of the Cappanana Formation. It is therefore reasonable, as shown by Henderson (1990) on his map, to correlate the Cappanana Formation with the Canberra Formation. All these relationships are summarised in Figure 2.

The distribution of species recognised in this paper is shown in Figure 3. Given the few localities in the Colinton Volcanics and Rothlyn Formation which have contributed to this study, it is likely that more of the taxa recorded in the Cappanana Formation extend to higher levels than shown. This also follows from the known distribution of species in the Canberra and Yass successions (Strusz 2010b), whose stratigraphic relationships and age have been discussed in detail by Percival and Zhen (2017) and Strusz and Percival (in press). Most of the species in the Bredbo fauna are known from those successions, where they extend from the mid-Wenlock into the Ludlow. Only three are there restricted to the Wenlock. *Mesoleptostrophia (Mesoleptostrophia) oepiki*, which is the most abundant species around Bredbo, is from the Canberra Formation, of Sheinwoodian age. *Hedeina oepiki* occurs in the Canberra Formation and in the Walker Volcanics, also of Sheinwoodian age. *Rufispirifer nucula* occurs in the Homerian Yarralumla Formation (but also in the Ludlow Molong Limestone farther north). It is clear that the succession from Cappanana Formation to at least the lower part of the Rothlyn Formation is of Wenlock age, and most probably Sheinwoodian.

SYSTEMATIC PALAEONTOLOGY

The specimens documented in this study are held by Geoscience Australia in the Commonwealth Palaeontological Collection (catalogue numbers prefixed CPC) and the Research School of Earth Sciences, Australian National University (catalogue numbers prefixed ANU), both in Canberra. Geoscience Australia also holds unregistered material from localities in the Bredbo area with field numbers CC105-108, 188-198, 304-318, BEG27, 34-42. Details of the localities used in this study are given in the Appendix. Specimens cited from the fossil collection of the Australian Museum, Sydney, bear the prefix AMF.

There are no new species in this fauna, so the following descriptions highlight only those features needed to establish specific identification. Classification follows that in the Treatise on Invertebrate Paleontology, part H, Brachiopoda (Revised) (Kaesler 1997-2006), and references to taxa at and above the level of genus may be found in the relevant parts of the Treatise.

Nearly all the samples are heavily weathered and decalcified moulds, and most are distorted to a highly variable extent by burial compaction and subsequent tectonic compression. A consequence of the weathering is that very few of the specimens are capable of withstanding the making of latex casts, even after strengthening, so this has not been attempted.

Class STROPHOMENATA Williams et al., 1996
Order STROPHOMENIDA Öpik, 1934
Superfamily STROPHOMENOIDEA King, 1846
Family LEPTOSTROPHIIDAE Caster, 1939
Genus MESOLEPTOSTROPHIA Harper and Boucot, 1978
Subgenus MESOLEPTOSTROPHIA Harper and Boucot, 1978

Type species

Mesoleptostrophia kartalensis Harper and Boucot, 1978, *nom. nov. pro Stropheodonta (Leptostrophia) explanata* Paeckelmann and Sieverts, 1932, *non* Sowerby, 1842. Emsian, Turkey.

Mesoleptostrophia (Mesoleptostrophia) oepiki
(Strusz, 1985)
Fig. 4.

Synonymy

Leptostrophia (Leptostrophiella) oepiki Strusz, 1985: 110-111, figs 4-5.

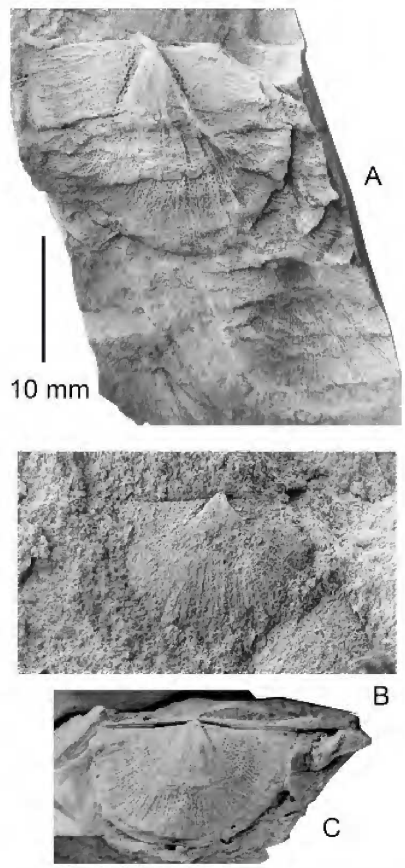

Figure 4. ***Mesoleptostrophia (Mesoleptostrophia) oepiki*****. A, CPC43761, ventral valve internal and external moulds, Cappanana Formation locality CC189; B, ANU33479B, ventral valve internal mould, Rothlyn Formation locality P57; C, holotype CPC24751, ventral valve internal mould, Canberra Formation, Fyshwick, Canberra.**

M. (Mesoleptostrophia) oepiki (Strusz); Strusz 2010b, figs 2, 3K-M; Strusz 2011: 33-35, fig. 2.

Holotype

CPC24751; Canberra Formation, Wenlock, Fyshwick, A.C.T.

Material

CPC43761, 43762, 43835 to 43838, locality CC189; CPC43794, locality CC190; CPC43824, 43825, locality BEG42, ANU33479B, 33480 to 33482, Pillans locality 57. All ventral valves.

Diagnosis

'Moderately concavo-convex *Mesoleptostrophia* of medium to large size, uniformly costellate, with long narrow alae, denticulation to 1/3 width of corpus; low ridges posterolaterally bounding subtriangular, posteriorly strongly impressed ventral muscle field, lateral to which valve floor is coarsely tuberculate; fine ventral myophragm; prominent notothyrial platform continuous with dorsal myophragm and pair of often prominent curved muscle-bounding ridges.' (Strusz 2011:33).

Description

Material comprises only ventral valves, mostly incomplete internal moulds. Valve semioval, weakly to moderately convex with very small beak. Ornament evenly costellate, about 20 in an arc of 5 mm at 5 mm radius. Where preserved, alae narrow and long, mostly separated from corpus by broad, shallow reentrants. Greatest observed hinge width calculated at 32.7 mm, greatest observed width of corpus in front of reentrants over 22 mm; Wh/Wc about 1.5; Lv/Wc 0.8-0.9. Interarea low, flat to slightly concave, moderately to strongly apsacline; delthyrium open, triangular.

Cardinal margin denticulate for about 40% of corpus width. Muscle field triangular to flabellate, smooth-floored, with fine to weak myophragm, impressed especially posteriorly, bounded laterally by weak to low, coarsely tuberculate ridges; valve floor outside muscle field finely and densely tuberculate. Apical process small, low.

Remarks

The differences between the two known species of *Mesoleptostrophia* in the Silurian of the Canberra-Yass Shelf are fully discussed in Strusz (2003:10; 2011:33), Strusz (2013:7) and Strusz and Percival (in press). The only consistent distinction between these very close and quite variable species lies in external morphology: *M. (M.) oepiki* differs from *M. (M.) quadrata* (Mitchell, 1923) in developing long slender alae separated from the corpus by shallow to absent reentrants, and coarser ornament. It remains uncertain whether these differences are purely a reflection of differing environments, or phylogenetic change within a lineage, but the conclusion of Strusz and Percival was that the former is unlikely. Also very similar is *Mesopholidostrophia bendeninensis* (Mitchell, 1923), but this can be distinguished by its very weak external ornament and detailed internal differences (Strusz 2013). The Bredbo occurrence can add nothing further.

Family EOPHOLIDOSTROPHIIDAE Rong and Cocks, 1994

Genus EOPHOLIDOSTROPHIA Harper, Johnson and Boucot, 1967

Subgenus MEGAPHOLIDOSTROPHIA Rong, Huang, Zhan and Harper, 2013

Type species

Eopholidostrophia (Megapholidostrophia) magnifica Rong et al., 2013:39-42, basal Anji Formation, Dakengwu, Chun'an County, Zhejiang Province, southeastern China; lower Rhuddanian, lower Llandovery, basal Silurian.

Diagnosis

'Large, up to 32.5 mm wide, *Eopholidostrophia* subgenus with extravagant dorsal geniculation and long trail at angles of 70-100 degrees to disc; anterior margin trilobate.' (Rong et al. 2013:39).

Eopholidostrophia (Megapholidostrophia) sp.
Fig. 5

Material

CPC43799. 43800, locality CC307.

Description

The ventral valves are all large (Lv to 41 mm, Ws to a calculated 58 mm) and strongly convex, with variable strength of geniculation. Alae small, may be separated from the corpus by a slot-like reentrant. Denticular plates triangular, extend to about 1/3 corpus width. Muscle field wide, flabellate, about 2/5 of valve length, posteriorly impressed, with a weakly grooved floor, divided by a fine myophragm. Valve floor outside muscle field finely but densely tuberculate.

The single dorsal internal mould is very incomplete and fairly strongly distorted; it is nearly flat, with narrow alae. Cardinal process lobes upright, disjunct, separated from a notothyrial platform by a prominent depression. Extending forward from the platform is a long fairly robust myophragm, and a pair of shorter moderately divergent ridges flanking a weakly expressed muscle field. Socket plates well developed, widely divergent.

Remarks

The relationship of *Eopholidostrophia (Megapholidostrophia)* to *E. (Eopholidostrophia)* is fully discussed by Strusz and Percival (in press). The material from Bredbo is sparse - one dorsal internal mould, six ventral internal moulds, all incomplete

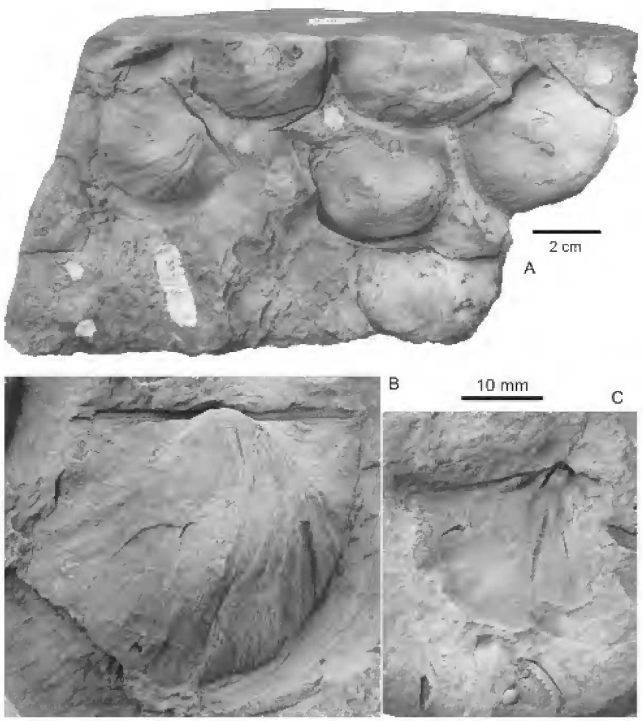

Figure 5. ***Eopholidostrophia (Megapholidostrophia)*** **sp. A, CPC43800, slab with six distorted ventral valve internal moulds; B, nearly complete ventral valve internal mould on CPC43800; C, CPC43799, incomplete and strongly distorted dorsal valve internal mould; locality CC307, Cappanana Formation.**

and not as well preserved as what is almost certainly the same species from farther south in the Quidong area, so can add nothing to that discussion.

Superfamily PLECTAMBONITOIDEA Jones, 1928
Family XENAMBONITIDAE Cooper, 1956
Subfamily AEGIROMENINAE Havliček, 1961
Genus EPILIDOAEGIRIA Strusz, 1982

Type species

Aegiria (Epelidoaegiria) chilidifera Strusz, 1982. Walker Volcanics, Canberra, Australia; Wenlock, Lower Silurian.

Epelidoaegiria minuta chilidifera Strusz, 1982
Fig. 6

Synonymy

Aegiria (Epelidoaegiria) chilidifera Strusz, 1982: 116-118, figs 9, 10.

Epelidoaegiria minuta chilidifera Strusz, 1982; Strusz 2003: 17-19, figs 12, 13, *cum syn.*

Holotype

CPC20387; Walker Volcanics, Sheinwoodian, Canberra, ACT.

Material

CPC43805 to 43810, locality CC312.

Diagnosis

'Relatively large and rarely sulcate *Epelidoaegiria* with fine unequally parvicostellate ribs, more costae on dorsal valve than on ventral, hinge line usually less than greatest width, prominent crescentic pseudodeltidium, and dorsal median septum extending slightly beyond bema to about valve mid-length' (Strusz 2003:17).

Remarks

As summarised by Strusz and Percival (in press), the two subspecies of *E. minuta* are very close morphologically, but can be separated on a number of points (see Table 5 in Strusz 2003). The generally distorted and rather poorly preserved Bredbo specimens are about the same maximum size as *E. minuta minuta* from Yass (measured Ls up to 4.2 mm, Ws up to 6.7 mm), but ribbing is finer and less angular than in that subspecies, there is no dorsal sulcus, the bema is weak or absent, and where present is the same length as the dorsal myophragm, both being less than the length of the valve. From these it follows that the Bredbo specimens belong to the type Canberra subspecies *E. m. chilidifera*.

Class RHYNCHONELLATA Williams et al., 1996
Order ORTHOTETIDA Waagen, 1884
Suborder ORTHOTETIDINA Waagen, 1884
Superfamily CHILIDIOPSOIDEA Boucot, 1959
Family CHILIDIOPSIDAE Boucot, 1959
Subfamily CHILIDIOPSINAE Boucot, 1959
Genus MORINORHYNCHUS Havliček, 1965

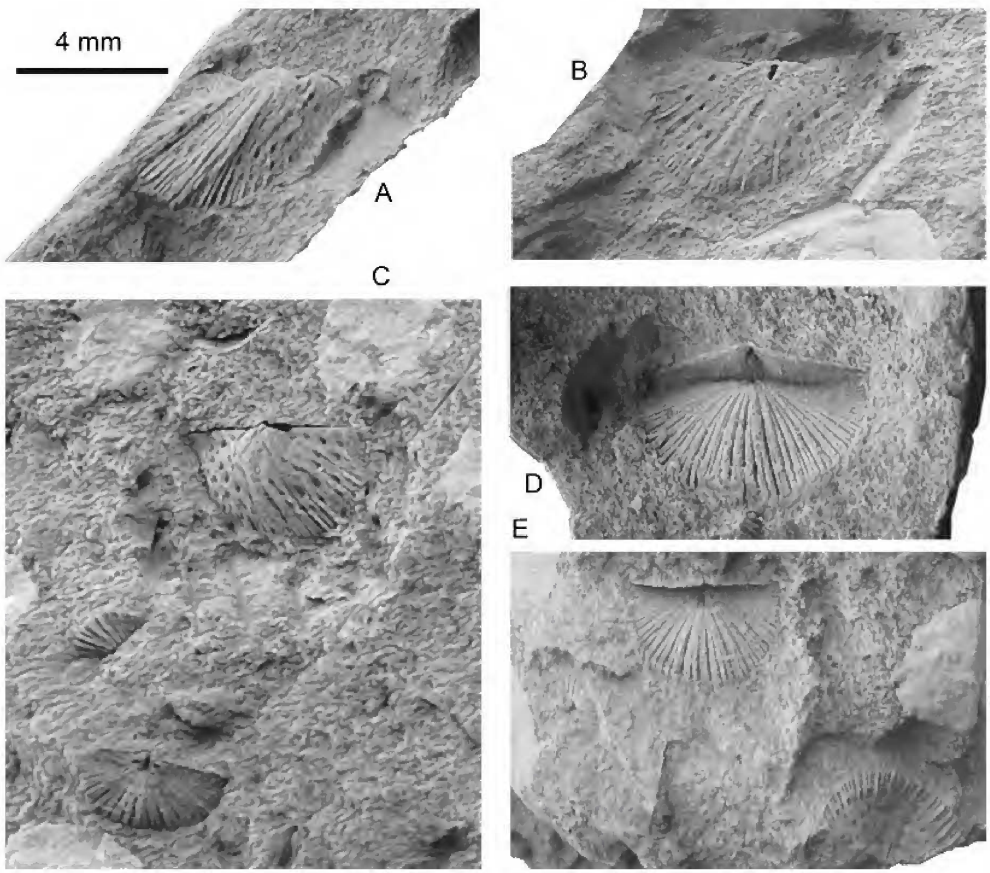

Figure 6. ***Epelidoaegiria minuta chilidifera*****. A, CPC43808, strongly distorted ventral valve internal mould; B, CPC43806, strongly distorted dorsal valve internal mould with weak myophragm, and bema just visible on right side; C, CPC43810, part of slab with ventral valve internal mould and dorsal valve external mould; D, CPC43807, dorsal valve and ventral valve external mould; E, CPC43809, dorsal valve external mould; locality CC312, Colinton Volcanics.**

Type species

Morinorhynchus dalmanelliformis Havliček, 1965, p. 291; Ludlow, Prague Basin, Bohemia.

Morinorhynchus sp. cf. *M. oepiki* Strusz, 1982
Fig. 7

Synonymy

cf. *Morinorhynchus oepiki* Strusz, 1982:119-122, figs 14-15.

Holotype

CPC20987; Walker Volcanics, Wenlock, Canberra, ACT.

Material

CPC43770, 43777, 43830, 43831, locality CC189; CPC43801, locality CC307; CPC43821, locality BEG38; ANU33483-33484 (counterparts), 33488, Pillans locality 56.

Description

Shell medium-sized, subquadrate in outline; ventral valves gently convex with greatest curvature at umbo, dorsal valve almost flat, anterior commissure rectimarginate. Largest observed ventral valve 17 mm long and about 21 mm wide (Ls/Ws ca 0.8), hinge almost as wide as valve, greatest width towards mid-

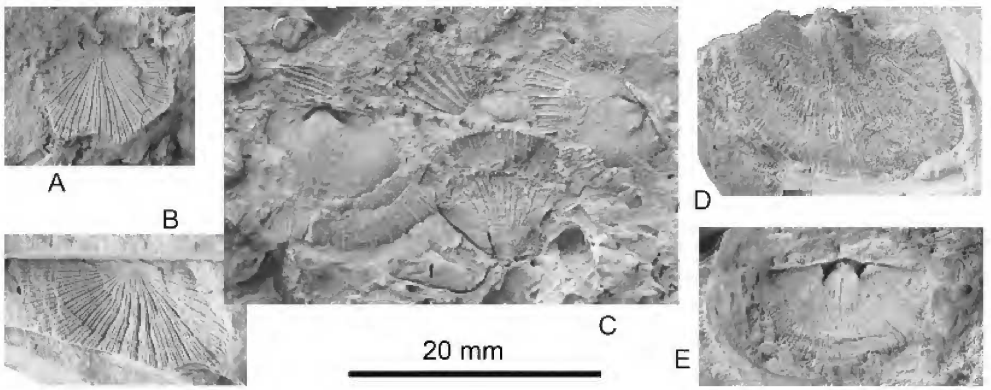

Figure 7. ***Morinorhynchus*** **cf.** ***oepiki*****. A, CPC43769, incomplete dorsal valve external mould; B, CPC43830, incomplete ventral valve external mould; C, CPC43777, dorsal and ventral valve internal moulds; D, CPC43770, ventral valve internal mould; E, CPC43831, ventral valve internal mould; locality CC189, Cappanana Formation.**

length. Ventral interarea strongly apsacline, delthyrial structure not preserved; dorsal interarea not known. Ornament finely unequally parvicostellate, about 28 ribs in 5 mm at 5 mm from beak; growth lines fine, crowded, well developed in intercostal furrows.

Teeth triangular, supported by strong, straight, upright dental plates diverging at about 70-80°. Muscle field flabellate, with faint myophragm, other details not preserved.

Dorsal interior known from one adult fragment, one juvenile. In juvenile, muscle field subquadrate, divided by broad low myophragm; socket plates very gently curved, diverge at 90°, continuous with low ridges flanking muscle field; cardinal process not preserved. Adult fragment shows one small, slightly curved socket plate, broad very low myophragm.

Remarks

The available material is sparse, somewhat distorted, and mostly fragmentary and poorly preserved; it is likely that better material would permit positive identification as *M. oepiki*. Allowing for distortion, ventral interior CPC43770 (Fig. 7D) is comparable with CPC24784, from the Canberra Formation in Fyshwick, Canberra (Strusz 1985:fig. 7F), which has dental plates less strongly curved than the type specimens from the Walker Volcanics of western Canberra. The dorsal interior CPC43777 is very like paratype CPC20419, from the Walker Volcanics (Strusz 1982:fig. 15D) except for less curvature of the socket plates. The species is also known from the Cappanana Formation east of Cooma (Strusz, 2013:8-9), where it dominates the fauna. A new species from the Delegate River Mudstone of Quidong (Strusz and Percival, in press) differs in a more elongate outline, with a subelliptical rather than subquadrate outline, a less strongly apsacline ventral interarea, and more strongly divergent socket plates.

Suborder ORTHIDINA Schuchert and Cooper, 1932
Superfamily ENTELETOIDEA Waagen, 1884
Family DRABOVIIDAE Havliček, 1950
Subfamily DRABOVIINAE Havliček, 1950
Genus SALOPINA Boucot in Boucot et al., 1960

Type species

Orthis lunata J. de C. Sowerby, 1839; Ludlow, Shropshire.

Salopina mediocostata Strusz, 1982
Fig. 8

Synonymy

Salopina mediocostata Strusz, 1982; Strusz, 2011:36, fig. 4; *cum syn.*

Holotype

CPC20337; Walker Volcanics, Wenlock, Canberra, ACT.

Material

CPC43763 to 43766, 43768, 43774, locality CC189.

Diagnosis

'Small subequally biconvex, broadly sulcate *Salopina* with single median costa on dorsal valve;

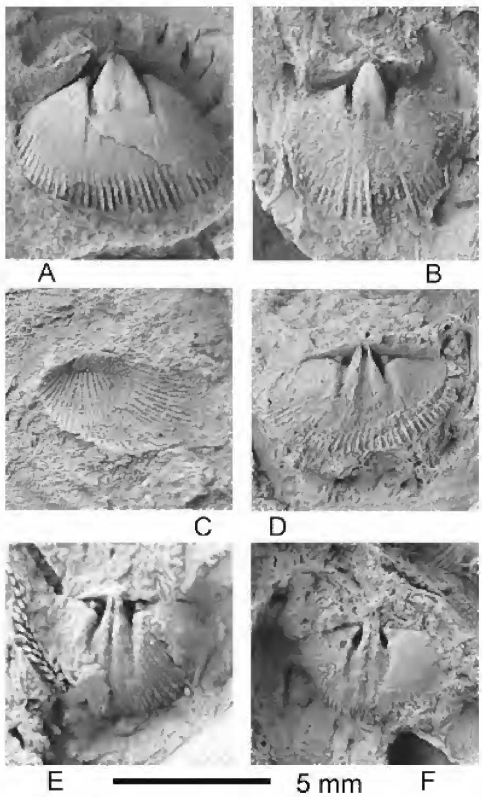

Figure 8. ***Salopina mediocostata*****. A, CPC43763, ventral valve internal mould with relatively wide muscle field; B, CPC43766, ventral valve internal mould with narrow muscle field; C, D, CPC43765, dorsal valve external and internal moulds; E, CPC43774, dorsal valve internal mould; D, CPC43768, dorsal valve internal mould; locality CC189, Cappanana Formation.**

teeth prominent, triangular, on short robust dental plates; ventral muscle field confined to subtriangular delthyrial cavity, somewhat raised, with abrupt fall at anterior edge; dorsal muscle field subquadrate with strongly raised lateral margins; widely separated subtriangular posterior adductor scars smaller and less impressed than anterior scars and separated from notothyrial cavity by oblique ridges; dorsal myophragm prominent, may extend beyond muscle field.' (Strusz 2002:68-69).

Remarks

Only separated valves have been seen in the Bredbo collections, and as with other species in the fauna most are not well preserved. Nevertheless the better ones are in complete accord with previous records of the species both externally and internally. The largest ventral valve, CPC43763, is 5.2 mm long, 6.9 mm wide, with Ls/Ws 0.75, Wh/Ws ca 0.8. This compares with values for the type series from the Walker Volcanics: maximum length 4.7 mm and width 5.9 mm, mean Lv/Ws 0.80, Wh/Ws 0.83. For the species of *Salopina* in the Yass succession, Strusz (2002:69) considered the form of the muscle fields, particularly that of the dorsal valve, to be the most reliable distinguishing feature. As at Yass, the Bredbo specimens have the species-specific longer, more quadrate dorsal field with distinctively shaped muscle bounding ridges and adductor scars, together with a myophragm which extends beyond the anterior edge of the field.

Order PENTAMERIDA Schuchert and Cooper, 1931
Superfamily CLORINDOIDEA Rzhonsnitskaya, 1956
Family CLORINDIDAE Rzhonsnitskaya, 1956
Genus CLORINDA Barrande, 1879

Type species

Clorinda armata Barrande, 1879. Hlubočepy Limestone, Prague Basin, Bohemia; Devonian.

Clorinda? sp. indet.
Fig. 9

Material

CPC 43826, locality BEG42; CPC43832, locality CC189.

Remarks

The two specimens are very small internal moulds - the largest is CPC43826, with a width of 3.75 mm - and are poorly preserved. There is no sign of crura, and by comparison with *Clorinda minor* (Booker, 1926) from the Yass Syncline, as revised by Strusz (2005), both are probably ventral valves. Both have median septa extending to about 2/5 valve length, which appear to support short, narrow spondylia. In the absence of larger specimens and usable dorsal valves, even generic identification is uncertain.

Order RHYNCHONELLIDA Kuhn, 1949
Superfamily RHYNCHOTREMATOIDEA Schuchert, 1913
Family RHYNCHOTREMATIDAE Schuchert, 1913
Subfamily RHYNCHOTREMATINAE Schuchert, 1913

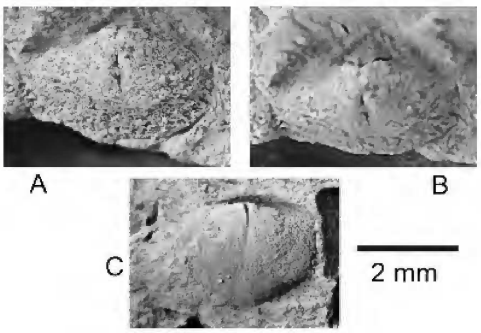

Figure 9. ***Clorinda*****? sp. indet. A, B, CPC43826, probable ventral internal mould with median septum supporting small apical spondylium, just visible in oblique posterior view (B); locality BEG42, Rothlyn Formation; C, CPC43832, slightly better specimen with median septum, narrow spondylium, smooth exterior; locality CC189, Cappanana Formation.**

Genus RHYNCHOTREMA Hall, 1860

Type species

Atrypa increbescens Hall, 1860. Caradoc, Canada.

Rhynchotrema? sp. indet
Fig. 10

Material

CPC 43816-43820, locality CC315. The available material comprises jumbled and mostly fragmentary external and internal moulds, of which eight, while not well preserved, are of use: one almost complete ventral external mould, two incomplete ventral internal moulds, two incomplete dorsal internal moulds, two moulds of the posterior end of a shell (one internal), and one of the anterior end.

Description

Shell small (greatest observed Ws 12.7 mm, Ls ca11.8 mm, Ls/Ws ca 0.93), biconvex, subpentagonal, with prominent suberect ventral beak. Fold and

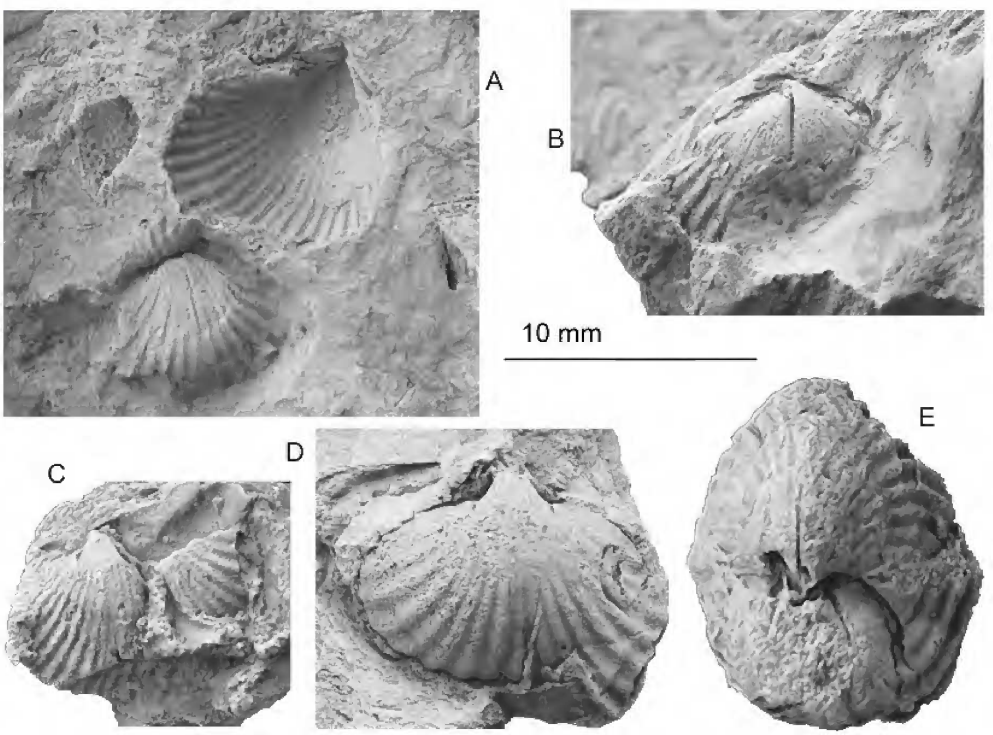

Figure 10. ***Rhynchotrema*****? sp. A, CPC43816, ventral valve external mould and dorsal valve internal mould; B, CPC43817 incomplete dorsal valve internal mould; C, CPC43820, ventral valve internal mould; D, CPC43818, ventral valve internal mould; E, CPC43819, posterior view, internal mould of conjoined dorsal and ventral valves; locality CC313, Colinton Volcanics.**

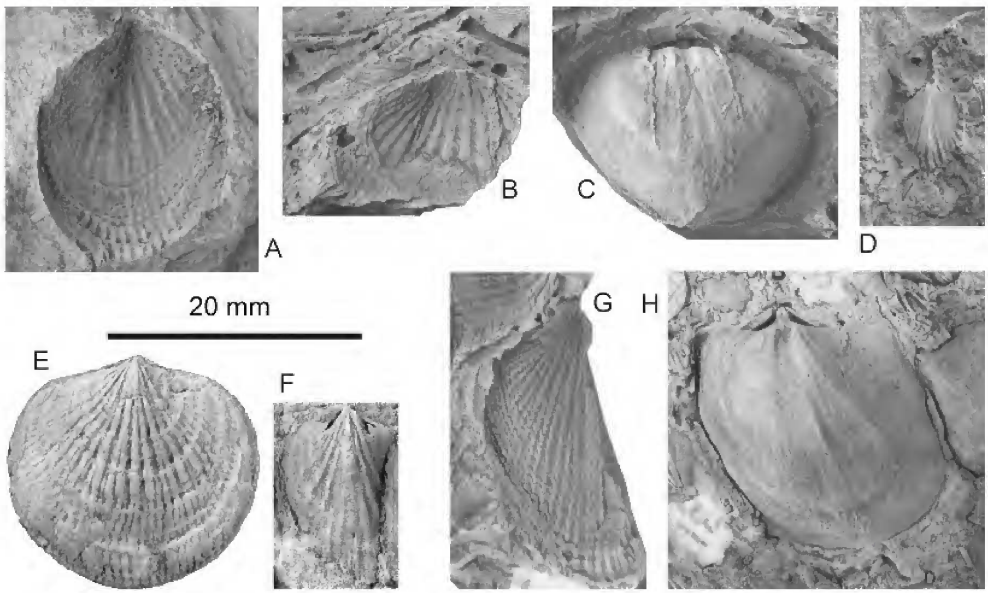

Figure 11. A-D, *Atrypa*? sp. A, CPC43780, ventral valve external mould; B, C, CPC43778, incomplete dorsal valve external mould and counterpart internal mould; D, CPC43779, juvenile ventral valve internal mould; all from locality CC189, Cappanana Formation. For comparison: E-F, *Atrypa (Atrypa) cf. dzwinogrodensis*; E, AMF29279, dorsal valve, Yarralumla Formation, Canberra, F, AMF129699, juvenile ventral valve internal mould, probably basal Black Bog Shale, Yass. G-H, *Atrypa (Atrypa) duntroonensis*; G, AMF110348, incomplete ventral valve external mould; H, AMF110407, dorsal valve internal mould; both Canberra Formation, Canberra.

sulcus faint or absent posteriorly, broad and very low anteriorly. Plications simple, extend from beaks. Cardinal area low, delthyrium wide, low, partly closed laterally by deltidial plates; foramen probably mesothyrid. Cardinal margin about 1/3 shell width.

Dental plates thin, widely separated, divergent forward and slightly laterally, flat to gently concave medially, clearly separated from valve walls; teeth small. Muscle field uncertain: in one poorly preserved posterior internal mould it appears to be elongate and somewhat impressed, in the other it has been damaged but appears to be shorter.

Cruralium short, supported by narrow, low to fairly well developed median septum; other details obscure or damaged.

Remarks

Identification of these specimens to even family level is uncertain. With well developed dental plates not fused to the valve walls, they cannot be Orthorhynchulids or Leptocoeliids. Ribs extending from the beaks means they are unlikely to be Trigonirhynchiids. Of Silurian Rhynchotrematids, *Pleurocornu* Havliček, 1961 differs markedly in its triangular outline and few plications, while *Stegerhynchus* Foerste, 1909 and *Stegocornu* Dürkoop, 1970 differ in having much stronger pauciplicate folds extending from at or near the beak. The Bredbo form differs from more typical *Rhynchotrema* in its very weak fold and sulcus, and small teeth.

Order ATRYPIDA Rzhonsnitskaya, 1960
Suborder ATRYPIDINA Moore, 1952
Superfamily ATRYPOIDEA Gill, 1871
Family ATRYPIDAE Gill, 1871
Subfamily ATRYPINAE Gill, 1871
Genus ATRYPA Dalman, 1828

Type species

Anomia reticularis Linnaeus, 1758; Ludlow, Gotland.

Atrypa? sp
Fig. 11.

Material

CPC43778 to 43780, locality CC189; CPC43815, locality CC313; CPC43827, locality BEG42.

Remarks

As discussed by Strusz (2011:43-44), the two described species of *Atrypa* from the Silurian of the Canberra-Yass Shelf are morphologically close, distinguished externally by differences in valve convexity. *Atrypa (A.) duntroonensis* Mitchell and Dun, 1920 is less markedly dorsibiconvex than *A. (A.)* sp. cf. *dzwinogrodensis* Kozłowski, 1929, with the ventral valve flanks often gently concave in the latter but not the former. Moreover, Strusz noted that these Australian taxa combine features of several genera within the subfamily, distinguished on internal as well as external morphology.

As only poor dorsal and no ventral interiors are known, even identification to generic level is uncertain, although on general appearance it is likely that one of the two above species of *Atrypa* occurs at Bredbo. The very strong, even convexity of dorsal valve CPC43778 (Fig. 11C), and the coarse proximal ribs on CPC43780 (Fig. 11A) are suggestive of *A. (A.)* sp. cf. *dzwinogrodensis* (compare AMF 29279, Fig. 11E), but of themselves these are far from conclusive.

Suborder LISSATRYPIDINA Copper, 1996
Superfamily LISSATRYPOIDEA Twenhofel, 1914
Family LISSATRYPIDAE Twenhofel, 1914
Genus ATRYPOIDEA Mitchell and Dun, 1920
Subgenus ATRYPOIDEA Mitchell and Dun, 1920

Type species

Meristina (?) *australis* Dun, 1904; Ludlow, New South Wales.

Atrypoidea (Atrypoidea) australis (Dun, 1904)
Fig. 12

Synonymy

Meristina (?) *australis* Dun, 1904: 318–319, pl. LXI, figs 3a–e.

Atrypoidea australis; Mitchell and Dun, 1920: 272, pl. XIV, figs 1–18, pl. XV, figs 8–9, pl. XVI, figs 7, 13.

Atrypoidea (Atrypoidea) australis (Dun, 1904); Strusz 2007:24–33, figs 16–21, *cum syn.*

Lectotype

MMF4014 (Geological Survey of NSW, Londonderry NSW); Molong Limestone, Ludlow, Molong, NSW.

Material

CPC43781, locality CC189; CPC43795 to 43797, locality CC198; CPC43822, locality BEG38.

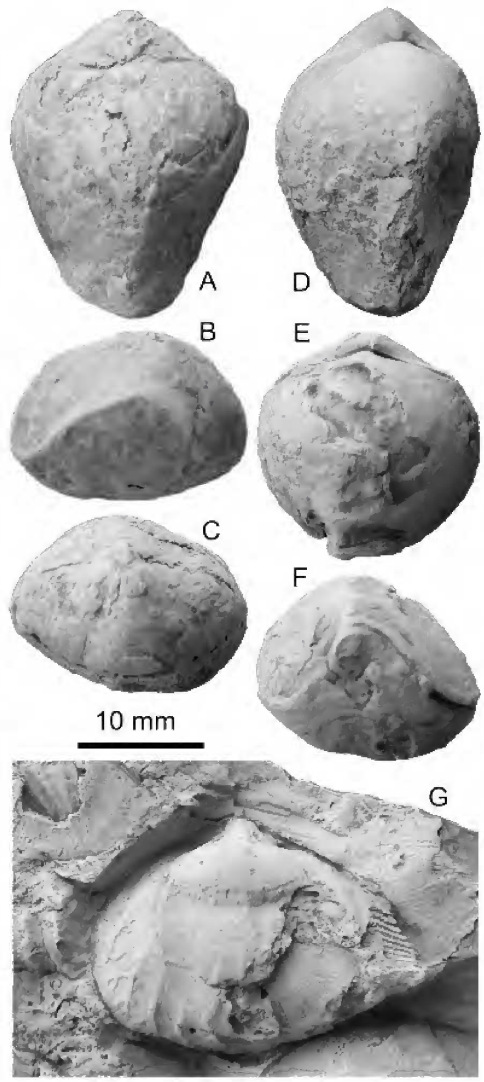

Figure 12. ***Atrypoidea (Atrypoidea) australis*****. A-C, CPC43795, shell in dorsal, anterior and posterior aspects; D, CPC43796, shell in dorsal aspect; E-F, CPC43798, shell in dorsal and anterior aspects; G, CPC43781, longitudinally compressed ventral valve internal mould. A-F from locality CC198, G from locality CC189, Cappanana Formation.**

Diagnosis

'Large, biconvex, generally rotund *Atrypoidea*, mostly somewhat longer than wide, with weak fold and sulcus but usually large rounded dorsal deflection

of anterior commissure, moderately curved lateral commissure; large delthyrium with narrow deltidial plates in smaller shells, obscured in larger shells with low, incurved ventral beak adpressed to dorsal umbo; cardinal extremities rounded; teeth and conical sockets widely divergent.' (Strusz 2007a:327).

Description

The shells from locality CC198 are generally worn, only three being measurable; other localities yielded four usable ventral internal moulds. There are no dorsal internals, and preservation is generally poor. Outline variable, elongate oval or shield-shaped to subcircular, greatest width between 40% and 50% of length. Largest shell 24.5 mm long, 16.7 mm wide, 14.1 mm thick (Ls/Ws 1.25, Ts/Ls 0.57). Lateral profile dorsibiconvex; ventral beak small, adpressed to dorsal valve. Broad poorly delineated dorsal fold arises anterior to mid-length, becoming strong only near anterior margin. Delthyrium large, triangular.

Ventral internal details poorly preserved. Teeth small, widely divergent, separated from cardinal margin by narrow slits. Muscle field impressed, subtriangular. Dorsal internal structures not seen.

Remarks

Despite the limited material, identification of the Bredbo specimens is certain. The measured specimens plot within the envelope of the data plots in Strusz (2007a), as do those from the Cappanana Formation east of Cooma (Strusz 2013:10-11), and can be matched with the published specimens from Yass and Molong - e.g. CPC43796 (Fig. 12D) is very similar to CPC39038 (Strusz 2007a:fig. 17J) from the Yass Formation, while CPC43798 (Fig. 12E-F) resembles AMF29197, the lectotype of synonymous *Atrypoidea angusta* Mitchell and Dun, 1920 from an unknown level at Yass (Strusz 2007a:fig. 16B), and AMF29193 from the Molong Limestone (Strusz, 2007a:fig. 19D).

Order ATHYRIDIDA Boucot, Johnson and Staton, 1964
Suborder ATHYRIDIDINA Boucot, Johnson and Staton, 1964
Superfamily NUCLEOSPIROIDEA Davidson, 1881
Family NUCLEOSPIRIDAE Davidson, 1881
Genus NUCLEOSPIRA Hall in Davidson, 1858

Type species

Spirifer ventricosus Hall, 1857. Lochkovian, New York.

?*Nucleospira paula* Strusz, 2007
Fig. 13

Figure 13. ?*Nucleospira paula*. CPC43767, dorsal? valve internal mould, partly concealed below a calical mould of a small tryplasmatid rugose coral; locality CC189, Cappanana Formation.

Synonymy

Nucleospira paula Strusz, 2007b:89-91, figs 2-4.

Holotype

ANU9573; Yarwood Siltstone Member, Black Bog Shale, Ludfordian, Yass NSW.

Material

CPC43767, locality CC189.

Remarks

The single specimen is a very small (estimated Ls 2.6 mm, Ws 2.9 mm) and incomplete internal mould of a smooth convex valve with a distinct myophragm extending the full length of the valve. While posterior details are poorly preserved, there is a suggestion of sockets parallel to the cardinal margin, indicating a dorsal valve, and comparable with the structure shown by the holotype (Strusz 2007b:fig. 2B).

Superfamily ANOPLOTHECOIDEA Schuchert, 1894
Family ANOPLOTHECIDAE Schuchert, 1894
Subfamily COELOSPIRINAE Hall and Clarke, 1895
Genus NAVISPIRA Amsden, 1983

Type species

Anoplotheca (Coelospira) saffordi Foerste, 1903.

Navispira? sp. cf. *N? bicarinata* Strusz, 2007
Fig. 14.

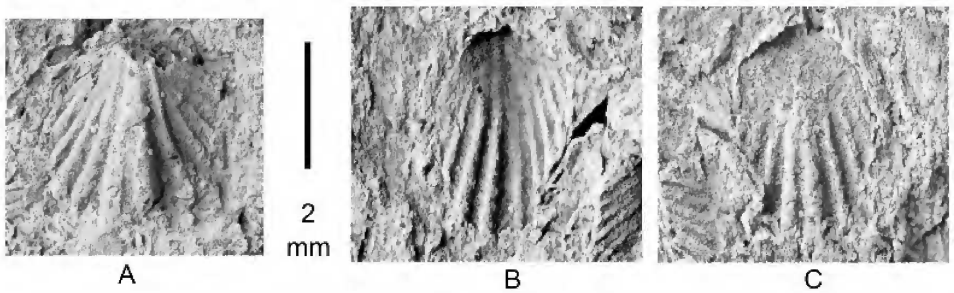

Figure 14. ***Navispira*? cf. *bicarinata*. A, CPC43776, ventral valve internal mould; B-C, CPC43773, counterpart ventral and dorsal valve external moulds; locality CC189, Cappanana Formation.**

Synonymy

cf. *Navispira? bicarinata* Strusz, 2007b:93-96, Figs 7-9.

Material

CPC43773, 43776, locality CC189.

Description

The two tiny specimens are a posteriorly damaged ventral internal mould, and counterpart ventral and dorsal external moulds, both distorted and rather poorly preserved. The former specimen is subcircular, 3.3 mm wide, and shows a very prominent rounded fold formed by two strong moderately divergent ribs. There are four pairs of lateral plications. While the umbonal region is damaged, there is the suggestion of short divergent dental plates. The second individual is similar, but with only three pairs of lateral plications on the ventral valve, and a very poorly preserved but apparently smooth umbonal area; Ws is 2.3 mm, Ls 3.5 mm. Microornament is not preserved.

Remarks

Strusz (2007b:97) has discussed the relationship between Silurian *Navispira* and *Coelospira*, concluding that the feature most characteristic of the former is the keel-like form of the ventral fold. Species of both genera occur at Yass, and the Bredbo specimens are very like *Navispira? bicarinata*, differing in slightly larger size, less divergent ribs on the fold with no sign of the fine median rib, and narrower lateral ribs (which could be an effect of distortion). While the Bredbo specimens are probably conspecific, they are too poor for confident identification.

Order SPIRIFERIDA Waagen, 1883
Superfamily CYRTIOIDEA Frederiks, 1924
Family CYRTIIDAE Frederiks, 1924
Subfamily EOSPIRIFERINAE Schuchert, 1929
Genus NANATTEGIA Strusz, 2010

Type species

Nanattegia yassensis Strusz, 2010a:93-97, figs. 6-7. Upper Silurian (Gorstian to Přídolí), Yass Syncline, NSW.

Diagnosis

'Tiny ventribiconvex spiriferide with V-shaped sulcus defined by strong plications, low dorsal fold defined by distinct furrows, subdued radially capillate micro-ornament; dental plates thin, subparallel, intrasinal to sulcus-bounding; cardinal process bilobed, outer hinge plates steeper than crural plates.' (Strusz, 2010a)

Nanattegia? sp.
Fig. 15.

Material

CPC43771, 43472, 43775, locality CC189.

Description

Material poorly preserved, very small, incomplete. Ventral valve pyramidal, capillate, capillae narrower than intervening flat-bottomed furrows; sulcus narrow, flanked by prominent plications. Dorsal valve gently convex, with low fold posteriorly narrow, flaring forward of mid-length, flanked by fairly shallow furrows. Outer plications, if present, very faint. Wide hinge line.

Ventral interior with thin upright dental plates, probably intrasinal to sulcus-bounding. Dorsal interior with small, steep outer hinge plates. No other details visible.

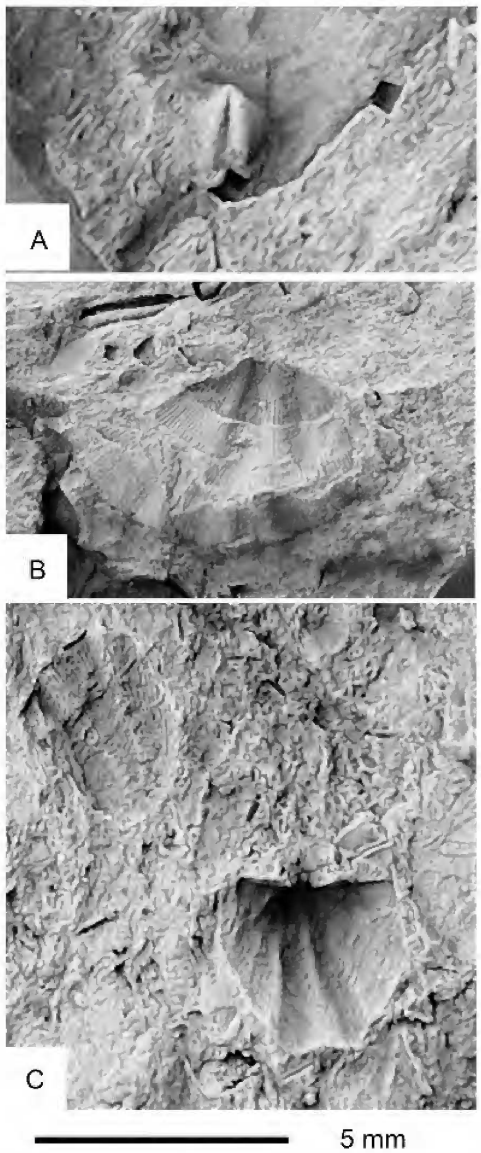

Figure 15. ***Nanattegia*****? sp. A, CPC43771, ventral valve; B, CPC43775, incomplete external mould showing** ***Myriospirifer*****-type capillae; C, CPC43772, relatively large pyramidal ventral valve external mould, and nearby incomplete dorsal? valve external mould showing style of capillae; locality CC189. Cappanana Formation.**

Remarks

These tiny spiriferides show the general external character of the genus, but the interiors are too poorly preserved for positive generic identification. They differ from other small spiriferides in the Bredbo fauna in their *Myriospirifer*-type micro-ornament (Havliček 1980). The others have coarser capillae as wide as the intervening furrows, and are considered to be juvenile *Hedeina*.

Genus HEDEINA Boucot, 1957

Type species

Anomia crispa Linnaeus, 1758. Silurian, Gotland.

Diagnosis

Eospiriferine with prominent smooth fold defined by strong U-shaped furrows; few lateral plications, the innermost narrower than fold but generally strong, the remainder decreasing rapidly in prominence laterally; dental plates extrasinal; ctenophoridium present.

Remarks

The above diagnosis is derived from the extensive discussion of the relationship between several eospiriferine genera in Strusz (2010a:97-101).

Hedeina oepiki Strusz, 2010
Fig. 16.

Synonymy

Hedeina oepiki Strusz, 2010a:103-104, fig. 13.

Holotype

CPC24871; Canberra Formation, Sheinwoodian, Canberra, ACT.

Material

CC43793, locality CC188; CPC43782 to 43790, locality CC189; CPC43839, locality CC307; CPC43823, locality BEG38.

Diagnosis

'Small *Hedeina* close to *H. bruntoni*, differing in subtriangular outline, wider hinge line, narrower fold.' (Strusz, 2010a:103)

Description

Shell fairly small, moderately ventribiconvex; outline transverse (Ls/Ws ca 0.8), subtriangular with prominent ventral umbo, wide hinge line (Wh/Ws 0.75-0.8), rounded cardinal angles; maximum width a little posterior to mid-length. Fold prominent, broadly rounded, flanked by less prominent pair of rounded plications originating at beak; 2-3 pairs

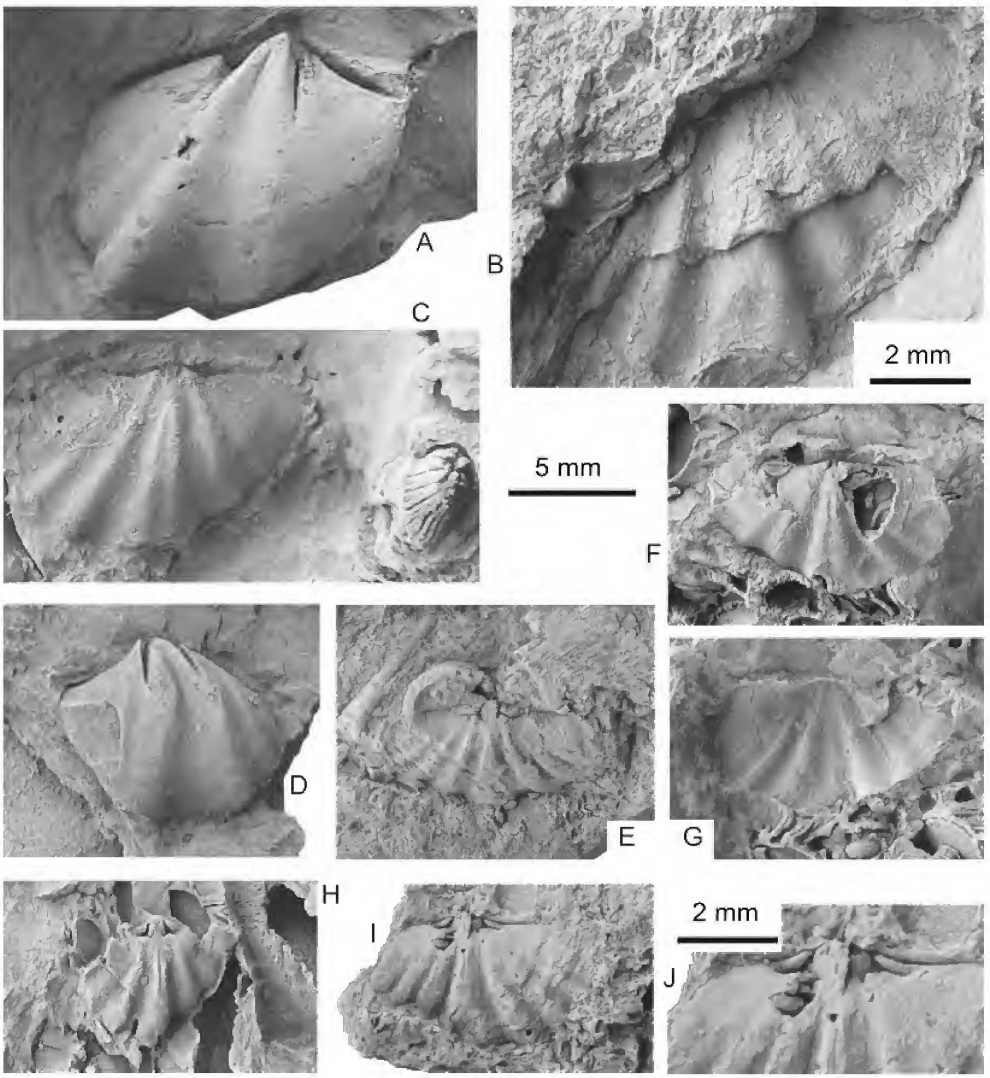

Figure 16. ***Hedeina oepiki.*** **A, CPC43782, ventral valve internal mould; B, CPC43786, partly decorticated dorsal valve showing capillae; C, CPC43789, dorsal valve internal mould (and adjacent calical mould of syringaxonid? rugose coral); D, CPC43783, ventral valve internal mould; E, CPC43787, dorsal valve internal mould; F-G, CPC43785, counterpart dorsal valve internal and external moulds; H, CPC43784, incomplete dorsal valve internal mould; I-J, CPC43788, dorsal valve internal mould and enlarged view of the cardinalia, showing the small ctenophoridium; locality CC189, Cappanana Formation.**

lateral plications, low beside fold, weakening outwards from low to faint. Microornament finely capillate, crossed by low growth lamellae which become crowded marginally in larger shells and with poor preservation may appear fimbriate.

Ventral interarea concave with open delthyrium flanked by narrow upright deltidial plates. Teeth small, dental plates robust, extrasinal, extending as far forward as 1/3 valve length. Muscle field obscure. Faint myophragm may be visible.

Cardinal process a small ctenophoridium. Sockets narrow, deeply conical, widely divergent; crural plates short but well developed, inclined; low

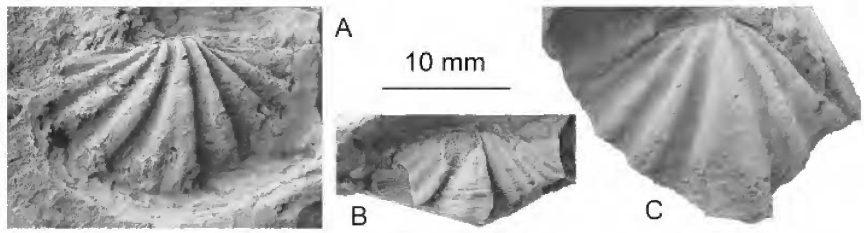

Figure 17. *Janius bowningensis*. dorsal valve internal moulds; A, CPC43771, B, CPC43791, C, CPC43772; A and C locality CC189, Cappanana Formation; B locality CC312, Colinton Volcanics.

notothyrial platform, weak myophragm.

Remarks

These generally rather poor specimens are placed in *H. oepiki* because of their small size, transverse shape, and relatively narrow fold. The species is otherwise known from the Canberra Formation and Walker Volcanics in the Canberra region, of Sheinwoodian age.

Genus JANIUS Havlíček, 1957

Type species

Spirifer nobilis Barrande, 1848; Wenlock, Bohemia.

Diagnosis

Strongly multiplicate eospiriferine with plications that bifurcate and intercalate, and may be present in sulcus (after Johnson and Hou 2006:1696).

Janius bowningensis (Mitchell, 1921)
Fig. 17

Synonymy

Spirifer bowningensis Mitchell, 1921:545-546, pl. 31 figs 21-22.

Janius bowningensis (Mitchell, 1921); Strusz, 2010a:90-93, figs 4-5, *cum syn.*

Lectotype

AMF29450, Black Bog Shale, Ludfordian, Yass NSW.

Material

CPC43791, 43792, locality CC189; CPC43811, locality CC312.

Diagnosis

'Fairly large, equibiconvex thin-shelled species of *Janius* with subdued ventral beak, wide U-shaped ventral sulcus and medially depressed dorsal fold which is noticeably widened marginally; plications curved outwards, subdivision variable, often asymmetric, sometimes by marginal trifurcation' (Strusz 2010a:90).

Remarks

The Bredbo specimens are four poorly preserved dorsal internal moulds and one fragmentary external mould, but are in every available aspect identical with the better-preserved specimens from the Yass Syncline. The largest is 16 mm long, and shows the typical wide, anteriorly flared fold with a depressed axis. A second is 10 mm long, with width more than twice length. The single external shows strong capillae crossed by crowded nodose growth lines - as in CPC39998 from Yass (Strusz 2010a:fig. 4H).

Suborder DELTHYRIDINA Ivanova, 1972
Superfamily DELTHYRIDOIDEA Phillips, 1841
Family DELTHYRIDIDAE Phillips, 1841
Subfamily HOWELLELLINAE Johnson and Hou, 1994
Genus RUFISPIRIFER Havlíček, 1987

Type species

Spirifer nucula Barrande 1879; Motol Formation, Bohemia, upper Wenlock.

Rufispirifer nucula (Barrande, 1879)?
Fig. 18

Synonymy

Spirifer nucula Barrande, 1879: pl. 2, figs 1-2.

Rufispirifer nucula (Barrande, 1879); Strusz 2010b:106-108, figs 15-16, *cum syn.*

Material

CPC43812 to 43814, locality CC312; ANU33479A, Pillans locality 57.

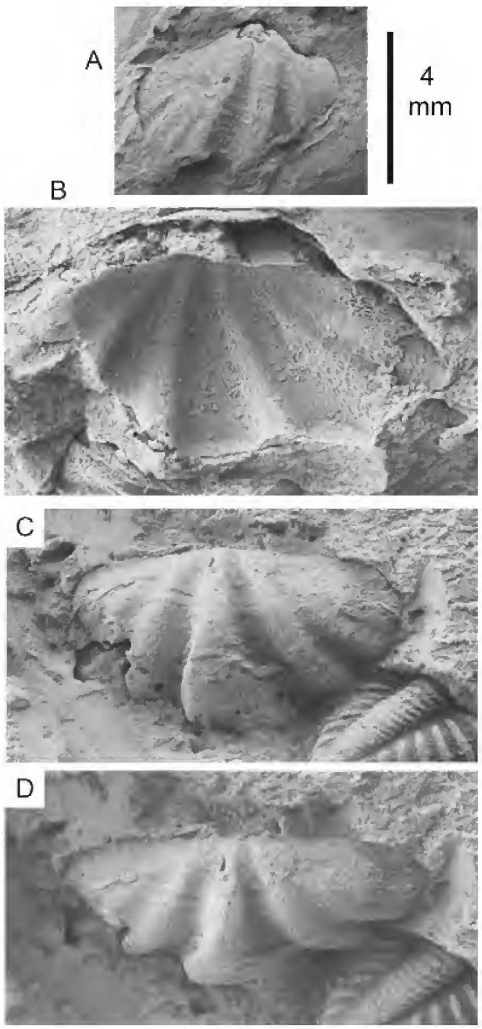

Figure 18. ***Rufispirifer nucula*?. A, CPC43812, ventral valve internal mould; B, CPC43813, dorsal valve external mould showing fimbriate microornament; C-D, CPC43814, dorsal valve internal mould, tilted in D to show small bilobed cardinal process, lack of crural plates; locality CC312, Colinton Volcanics.**

Description

The better preserved ventral valves have a well developed sulcus and flanking plications, a relatively wide hinge line (Wh/Ws about 0.8), prominent umbo, concave interarea with open triangular delthyrium flanked by narrow upright deltidial plates, and short extrasinal dental plates. Dorsal valves are moderately convex with prominent fold, low umbo; the cardinal process appears to be bilobed (CPC43814, Fig. 18D), with each lobe longitudinally grooved; while other details of the cardinalia are more obscure, there is a low notothyrial platform but no crural plates. Microornament is capillate, of the delthyrid type described by Williams et al. (1997:342-345) and Strusz (1985), and so distinct from the eospiriferid type found in small *Hedeina*.

Remarks

While generally very poorly preserved, these small ribbed spiriferides are most likely to be the same species as occurs in the late Wenlock Yarralumla Formation of Canberra (Strusz 1984) and Bohemia (Havliček and Štorch 1990), and the Ludlow of Molong (Strusz 2010b).

Suborder DELTHYRIDINA Ivanova, 1972
Superfamily RETICULARIOIDEA Waagen, 1883
Family RETICULARIIDAE Waagen, 1883
Subfamily RHENOTHYRIDINAE Gourvennec, 1994
Genus SPIRINELLA Johnston, 1941

Type species

Spirinella caecistriata Johnston, 1941; Wenlock, Yass, New South Wales.

Diagnosis

'Medium size; equidimensional to slightly transverse, smooth, inequivalve with apsacline, curved central interarea; cardinal angles rounded; fold and sulcus smooth, very low, poorly defined except near uniplicate commissure; flanks lacking plications, or with 1-3 weak plications flanking fold and sulcus anteromedially; numerous closely spaced growth lamellae with marginal spine bases or papillae; moderately long, divergent dental plates, short delthyrial plate or apical thickening, and variably impressed ventral muscle field; ctenophoridium and short posteriorly sessile crural plates.' (Strusz 2010a:108).

Spirinella caecistriata Johnston, 1941
Fig. 19

Synonymy

Spirinella caecistriata Johnston, 1941:161-167, pl. VII, figs 1-11.

Spirinella caecistriata Johnston, 1941; Strusz 2011:45-46, fig. 12, *cum syn.*

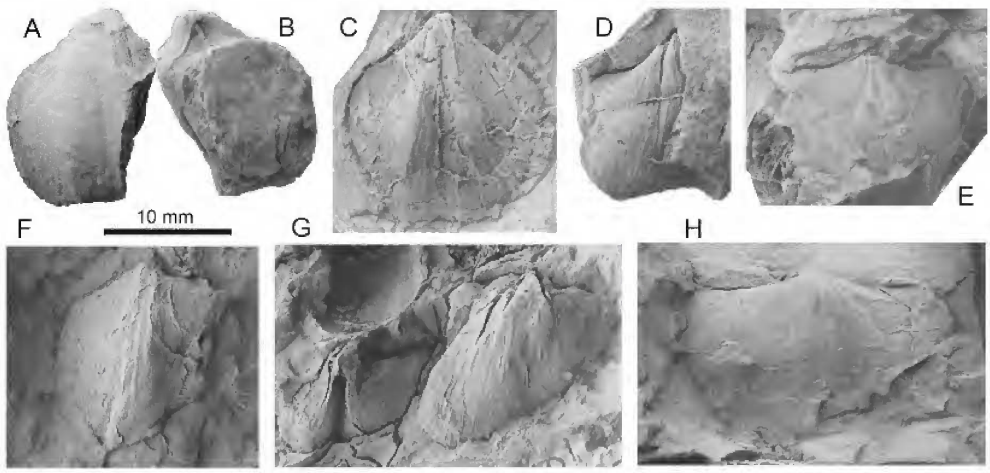

Figure 19. ***Spirinella caecistriata*****. A-B, CPC43833, incomplete ventral valve, viewed obliquely in B to show interarea; C, CPC43828, ventral valve internal mould; D, CPC43829, incomplete ventral valve internal mould; E, CPC43802, dorsal valve internal mould; F, CPC4380, ventral valve internal mould; G, CPC43803, two strongly distorted ventral valve internal moulds; H, CPC43834, dorsal valve internal mould. A-B, locality CC198, upper Cappanana Formation; C-D, locality BEG42, Rothlyn Formation; E-H, locality CC308, Cappanana Formation.**

Holotype

AM F39376; Yass Formation, Homerian, Yass, NSW

Material

CPC43833, locality CC198; CPC43802-43804, 43834, locality CC308; CPC43828, 43829, locality BEG42.

Diagnosis

'Suboval, moderately ventribiconvex *Spirinella* with prominent ventral umbo, erect to slightly incurved beak; interarea concave, weakly apsacline, not well delineated laterally. Teeth small, triangular; dental plates long, moderately divergent, continued anteriorly by grooves of *vascula media*; ventral muscle field generally somewhat impressed, elongate, longer than dental plates; delthyrial plate or apical thickening small, crescentic; crural plates narrow, triangular, more or less convergent downwards, rest posteriorly on small notothyrial platform; lanceolate dorsal adductor field and myophragm.' (Strusz 2011:46).

Description

There is one incomplete, distorted, but otherwise reasonably well preserved ventral valve from locality CC198, a very incomplete ventral internal mould from locality BEG42, and a jumbled assortment of mostly broken, strongly distorted internal and external moulds on one specimen from locality CC308. Despite the mostly poor preservation specific identity is certain.

The valve from CC198 is convex and of moderate size (Ls 15.6 mm, Ws est. 15 mm, hinge about 2/3 Ws), smooth, with a narrow, shallow sulcus, and microornament typical of the genus. The hinge line is fairly long, the cardinal angles are rounded, the interarea concave, the delthyrium open and flanked by narrow upright deltidial plates. There is a very small concave delthyrial plate beneath the apex of the delthyrium. The ventral internal mould from BEG42 has long, moderately divergent dental plates, and is comparable with CPC24875 from the Canberra Formation (Strusz 2010a:fig. 18O).

External moulds from CC308, while less well preserved, do show the general form and typical microornament of the genus. The best of the ventral internal moulds show long divergent dental plates and a faintly impressed muscle field whose outline is obscure. Dorsal internal moulds are poorer, but one shows a small bifid ctenophoridium such as seen on CPC24876 (Strusz 1985:fig. 14C-D) from the Canberra Formation - in fact the two valves are very similar, even to the degree of distortion.

Remarks

The genus and species have been comprehensively analysed by Strusz (2010a:108-117).

ACKNOWLEDGEMENTS

This study is based on material collected in the nineteen sixties by parties of final-year undergraduate students working at the then Bureau of Mineral Resources, but has had to await analysis until the much better preserved faunas of the Yass Syncline had been fully studied. I would like to offer them, and the staff geologists who supervised them, belated thanks for their efforts. My thanks also to Natalie Schroeder of Geoscience Australia for her help in retrieving the collections, and likewise to Brad Pillans, Lynne Bean and Valerie Elder of the Research School of Earth Sciences, ANU, for making available Brad's honours thesis and specimens. Finally, I would like to thank David Barnes for photographing some very small and difficult specimens, and Ian Percival (New South Wales Geological Survey) for helping with that photography, and for his many useful comments on the manuscript. The work has been carried out in my capacity as School Visitor at ANU, and Research Associate of the Australian Museum, Sydney.

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APPENDIX - LOCALITY LIST

The localities used in this study, and shown in Fig. 1, lie on the Bredbo 1:25 000 sheet 8726-3S (Geoscience Australia localities prefixed CC) and Murrumbucca 1:25 000 sheet 8725-4N (Geoscience Australia localities prefixed BEG), both 2016 editions. These localities were originally marked on 1959 air photos (held by Geoscience Australia library), and have been plotted on enlargements of these recent maps. Grid references to localities which were not used (CC191-197, 304-306, 309-311; BEG27, 34-37, 39-41) have been entered on the original locality cards. The two localities from which Pillans (1974) collected fossils have also been replotted on the new maps. Grid references in most cases are to the nearest 10 metres; in a few instances where streams, trees or roads have changed significantly the accuracy may be reduced to the nearest 50 metres. This list places the original field numbers in parentheses (as those are what is what is marked on the air photos and samples), and also gives the current stratigraphic position (after Henderson 1990), fossils recorded, and lithology.

CC188 (B24) Bredbo FA9903.1852; ca 200 m SSW of woolshed S of Bredbo-Jerangle road, in gully, a western tributary of Cappanana Creek parallel to and S of access track to woolshed; Cappanana Formation, mudstone fairly low in the formation. *Hedeina oepiki,* indet. rugosan, bivalve.

CC189 (B38, B38a) Bredbo FA9841.1946; in gully just S of Bredbo-Jerangle road; Cappanana Formation, mudstone. *Mesoleptostrophia (Mesoleptostrophia) oepiki, Morinorhynchus cf. oepiki, Salopina mediocostata, Atrypa? sp., Atrypoidea (Atrypoidea) australis, ?Nucleospira paula, Navispira? cf. bicarinata, Nanattegia sp., Hedeina oepiki, Janius bowningensis, Favosites*, heliolitid, syringoporid, alveolitid, *Rhizophylum interpunctatum*, syringaxonid? rugosan, *Tryplasma, Batocara, Onycopyge*, bryozoans, gastropods.

CC190 (B60) Bredbo FA9826.2142; on gully bank, about 1.5 km NW of Bredbo-Jerangle road; Cappanana Formation, interbedded nodular silty limestone and siltstone close to the top of the formation. *Mesoleptostrophia (Mesoleptostrophia) oepiki*.

CC198 (point 6 in section between C30 and C37) Bredbo FA983.188; gully extending E from Connollys Gap to Cappanana Creek, locality described as ca 40 m S of track to woolshed, ca 300 m SE of gate on Bredbo-Jerangle road; Cappanana Formation, calculated from dips to be 860 m above the Ordovician, in the transition zone to the Colinton Formation; mudstone with calcareous nodules. *Atrypoidea (Atrypoidea) australis, Spirinella caecistriata*.

CC307 (D10b) Bredbo FA9827.2304; in Cappanana Creek just N of track crossing; Cappanana Formation, mudstone. *Eopholidostrophia (Megapholidostrophia) sp., Morinorhynchus cf. oepiki, Hedeina oepiki; Phaulactis?, Batocara*, bryozoans.

CC308 (D21b) Bredbo FA9814.2266; near small gully, west of Cappanana Creek about 750 m SE of woolshed N of Bredbo-Jerangle road; Cappanana Formation, mudstone with interbedded limestone lens. *Spirinella caecistriata*.

CC312 (E4) Bredbo FA9783.1463; in gully 200 m NE of access road to 'Cappawidgee' farmhouse about 3.9 km from the turnoff on the Bredbo-Jerangle road; Colinton Volcanics, siltstone. *Epelidoaegiria minuta chilidifera, Janius bowningensis, Rufispirifer nucula?; Batocara.*

CC313 (E5) Bredbo FA9791.1465; in gully 315 m NE of 'Cappawidgee' access road about 3.9 km from turnoff on Bredbo-Jerangle road, 115 m above CC312; Colinton Volcanics, siltstone. *Rhynchotrema*? sp., *Rufispirifer nucula*?

BEG38 (H13) Murrumbucca FA9882.1280; west side of track, about 1.5 km S of 'Cappawidgee' farmhouse; Cappanana Formation 12 m below Colinton Volcanics, mudstone. *Morinorhynchus cf. oepiki, Atrypoidea (Atrypoidea) australis, ?Hedeina oepiki; Batocara.*

BEG42 (J18) Murrumbucca FA9621.1272; just south of Billilingra Siding on abandoned Queanbeyan-Cooma railway; Rothlyn Formation, siltstone. *Mesoleptostrophia (Mesoleptostrophia) oepiki, cf. Clorinda sp., Atrypa? sp., Spirinella caecistriata; Batocara.*

Pillans 56 Murrumbucca FA9583.1312; gully about 70 m west of abandoned railway line, about 290 m north of Billilingra Siding; Rothlyn Formation, poorly sorted gritty tuffaceous mudstone. *Morinorhynchus* cf. *oepiki*.

Pillans 57 Murrumbucca FA9617.1308; gully about 470 m NW of Billilingra Siding on abandoned railway; Rothlyn Formation, fine pyritic sandstone. *Mesoleptostrophia (Mesoleptostrophia) oepiki, Rufispirifer nucula?*